National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

BASIC CONTRACT

Reply to Attn of: 442

TO: 214.1/Contract Specialist/Mr. Glenn Emig

FROM: [redacted] Instrument Manager

SUBJECT: Technical Evaluation and Analysis of [redacted] Proposal P0600-1064 "Wide Field Camera 3 Science Instrument Subsystems"

REFERENCE: Technical Proposal in Response to Request for Proposal No. RFP5-[redacted]

Pursuant to the referenced proposal, the technical evaluation and analysis of the subject proposal has been completed and approved, and the results and other comments are listed below.

The personnel listed in the table below participated in the evaluation of the subject technical proposal.

TABLE 1. Proposal Evaluators.

Name	Organization	Position on WFC3
Ray Boucarut	551	Optics Engineer
Ed Cheng	685	Instrument Scientist
Ed Cheung	442	Electrical Engineer
Sharon Cooper	543	Mechanical Lead
Mike Davis	442	Systems Engineer
Patsy Dickens	545	Contamination Lead
Jamie Dunn	442	I&T Manager
Doug Fineberg	730	Systems Engineer
Bill Eichhorn	551	Optical Stimulus Lead
Kathy Jenkins	549	Verification Lead
Bo Lewis	302	Safety Engineer
John Maliszewski	685	Detector Lead
Kathy Nieman	442	Configuration Manag't Specialist
Thai Pham	740	Instrument Manager
Brian Rehm	582	Software engineer
Rick Stavely	545	Thermal Lead
Rich Williams	302	EEE Parts Engineer

SUMMARY

The subject proposal was submitted by [redacted] in response to the NASA/GSFC Request for Proposal (RFP) number RFP5-[redacted] for support in the development of the Wide Field Camera 3 (WFC3) radial instrument to be installed in the Hubble Space Telescope (HST) during Servicing Mission 4 which is currently planned for July 2003.

This proposal was submitted in a cost plus incentive fee amount of $[redacted] ($[redacted] in estimated cost and $[redacted] fee). This fee is approximately [redacted]% which is excessive and inconsistent with the level of risk involved since there is a significant amount of design heritage within the proposed scope of work. Therefore, the fee should be negotiated down to 10% which is more reasonable and consistent with the level of risk involved. The proposed fee structure is not acceptable, therefore a modified version is recommended.

The contractor's proposed versus Goddard recommended labor and computer hours and costs are summarized in table 2.

TABLE 2. Summary of Proposed Vs. Recommended Hours and Costs.

Categories	Proposed	Recommended	Delta
Labor Hours	211,495	198,858	-12,637
Computer Hours	12,494	11,699	-795
Materials Cost	$[redacted]	$[redacted]	-$146,608
Travel Cost	$[redacted]	No Change	0

As shown in the table above, I take exceptions to the proposed labor hours, computer hours, and materials cost and accept the travel cost as proposed.

The proposed schedule is exactly what Goddard had requested and is therefore acceptable. The deliverables comply with the RFP with adequate spares and therefore are acceptable.

The proposal had deviations and/or exceptions to the statement of work (SOW), the Data Requirements Document (DRD), and the Contract End Item Specification (CEIS). Fact finding sessions with the

contractor had resolved all the deviation/exceptions except for three CEIS exceptions which will be worked out with the contractor within the next couple of weeks. Presently, as the result of the fact-finding discussions, Goddard had agreed to change six CEIS items per the contractor - configuration control requests (CCR's) will be submitted to the HST configuration control board (CCB). The CEIS changes and the three open CEIS deviation/exceptions will not have any effect on the cost or schedule as proposed, therefore, the proposal evaluation effort should proceed without delay. The status of the exceptions/deviations is summarized in Table 3.

TABLE 3. Summary of Deviations/Exceptions Status

Document	Number of Exceptions and/or Deviations		
	Received	Resolved	Open
SOW	10	10	0
DRD	65	65	0
CEIS	30	27	3

In summary, with relatively minor exceptions taken to the incentive fee, the fee structure, the direct labor hours, the computer usage hours, and the materials cost, I believe this proposal exhibits a firm commitment from [redacted] and accurately reflects the technical and programmatic requirements to effectively and efficiently perform the requested scope of work.

INTRODUCTION

The Wide Field Camera 3 (WFC3) is a fourth generation Hubble Space Telescope (HST) instrument designed to replace the Wide Field Planetary Camera 2 (WFPC2) during Servicing Mission 4 (SM4) in the year 2003. WFPC2 replaced the original Wide Field/Planetary Camera, WF/PC (1), in the HST during the first servicing mission in December 1993. WF/PC (1) was deployed with the HST in 1990.

WFC3 is a facility-class instrument being developed to ensure HST has a high quality imaging capability until the end of the HST mission which is presently planned for 2010. Being a facility instrument, the WFC3 is developed for the HST user community. Its developers will not receive any guaranteed observation time on HST. The work is done as a service to the astronomical community.

WFC3 is being designed to contain two distinct imaging channels, the ultraviolet/visible (UVIS) channel and the infrared (IR) channel.

WFC3 represents a new approach to the development of HST scientific instruments. The teams of Government, Academia, and Industry who worked to build WF/PC (1), WFPC2, and six other HST instruments are working together on WFC3, leveraging their expertise and experience to provide a superior instrument at the lowest possible cost.

GSFC, with the support of all the development partners, will manage the development of WFC3 and lead the instrument level integration and test (I&T) activities at GSFC. After I&T, the instrument will undergo a calibration period and upon its completion will be delivered to the HST project.

[redacted] is one of the development partners and has been supporting the instrument in systems engineering and initial detailed designs of the majority of the instrument components. This support has been provided through the Hubble Instrument Support (HIS) contract delivery order. The proposal under evaluation is for [redacted] to provide the following support to the WFC3 program:

a) Systems Engineering.
b) Design, fabrication, assembly and testing of all mechanisms - excluding the Selectable Optical Filter Assembly (SOFA) but including the outgas testing, functional testing, and integration and alignment of the unit inside the Optical Bench.
c) Design, fabrication, assembly and testing of all electronics - including all electronics component or assemblies and harnessing but excluding RIU's, Expander Units, and GFE EEE parts.
d) Design, fabrication, assembly and testing of the Detector Assemblies- excluding the definition, procurement, and characterization of the UVIS and IR detector chips. Non-flight detector enclosures will be delivered to GSFC with the Optical Assembly. Flight units will be delivered and installed during I&T at Goddard.
e) Design, fabrication, procurement, assembly and testing of Optics - including mounts and baffles. All optical filters, grisms, and AlMgF2 optical coating will be GFE.
f) Assembly, alignment and testing of the Optical Assembly - excluding the design, fabrication, and test of the optical bench.
g) Design, fabrication, assembly and testing of the Calibration Subsystem.

h) Develop and test flight and ground software and operations codes.
i) Provide post delivery support for integration, detector change-out, alignment, test, transport, launch site activities, launch, and post-launch activities at GSFC and the launch site.

TECHNICAL EVALUATION

Two [redacted] proposal volumes (Technical/Management and Cost/Business) were received on June 13, 2000. Since then and in parallel with my evaluation effort, the Goddard WFC3 discipline leads (shown in Table 1) and the instrument scientist have reviewed the sections of the proposal that are relevant to their area of responsibility, expertise, or interest. Their comments/questions have been combined with mine, totaling over 130 questions/comments, and forwarded to the contractor to address during fact-finding sessions. This Goddard team participated in several fact finding sessions where the contractor provided written responses for and the opportunity to discuss all the comments/questions (questions/comments with contractor provided written responses are attached as Appendix A). The SOW/DRD/CEIS exceptions were also discussed and worked during these fact-finding sessions.

The following categories were evaluated: Schedule, deliverables, SOW/DRD/CEIS deviations and/or exceptions, fee, and direct costs such as labor hours, computer usage hours, materials, and travel.

Schedule

The proposed delivery schedule is the exact schedule that the WFC3 program has generated with the support of all the partners and their subsystems, therefore, it is acceptable. The Government Furnished Equipment (GFE) delivery schedule was discussed with the contractor and it has been mutually agreed upon. The GFE items with delivery dates are shown in Appendix C.

Deliverables

The proposed deliverables are appropriate and acceptable. The list has been worked with the contractor, and it complies with the spares philosophy that was mutually agreed upon. A point to note is that a correction was noted during the fact-finding session about mechanism spares. The corrector mechanism will be the only [redacted] provided mechanism with a fully assembled and

tested spare unit. The other three [redacted] provided mechanisms will only have spare parts that will not be assembled or tested. This point is clarified in the revised deliverables list provided by the contractor and included as Appendix D. The materials cost will remain the same, but the assembly and test hours for the un-assembled spare mechanisms will be saved and they are addressed in the labor hour evaluation matrix in Attachment 1.

SOW Deviations/Exceptions

The ten deviations and exceptions to the Statement of Work (SOW) taken by the contractor have been discussed with the contractor's Program Manager and are mutually agreed to be closed with no changes to the proposal. These deviations/exceptions are summarized in Appendix B along with my responses/comments.

CEIS Deviations/Exceptions

A fact-finding meeting was held with [redacted] to specifically resolve the Contract End Item Specification (CEIS) items which [redacted] took exceptions to. Of the 30 exceptions received, 21 have been closed through discussions or clarifications with no changes to the specification. Six items will require Configuration Change Requests (CCR's) to be submitted to change the CEIS. The details of the CCR's have been agreed upon and they will not result in any increase in cost. Three items are still being worked and expected to be closed in two weeks but their outcome will not affect the level of effort, proposed cost or schedule. The CEIS deviations/exceptions status is summarized in Appendix B.

DRD Deviations/Exceptions

The Data Requirements Document (DRD) exceptions and deviations listed in the Ball proposal, and reproduced with present status in Appendix B, were taken from a review version of the DRD. [redacted] takes no exception to the present released version of the DRD.

Fee

The proposed cost, schedule, and performance incentive fee target is [redacted]%. This is unreasonably high for the proposed scope of work

which has significant design heritage and hardware/software re-use. For example: The UVIS detector housing is the exact design of the ACS system with the addition of vent lines and WFC3 specific interfaces; the IR detector housing has been prototyped and successfully thermally and mechanically tested; the electronics boxes have 50% to 100% design re-use and/or heritage each; all the mechanisms have been developed for previous HST instruments and will just require slight modifications to accept different optics, except the corrector mechanisms which also received modifications for ease of fabrication and assembly; one third of the software codes are exact re-use from ACS and COS, and the rest just need modifications.

A more reasonable fee structure is recommended and shown in Table 4. Cost, schedule, and performance fees should not be equally weighed as proposed because the level of risks associated with these areas are not equal.

The cost and schedule incentive allocations proposed are similar to those submitted in the RFP except the submitted milestones #7 and #8 were deleted. This is acceptable except for the cost fee allocation for milestone #7. The contractor does have influence in the completion of the instrument environmental testing at Goddard and so the milestone should be allocated a cost fee as shown in Appendix E.

The proposed versus recommended IR and UVIS detector performance incentive metrics are shown in Appendix E. The recommended values are more reasonable because they stress and incentivize what we feel is important to the successful outcome of the program and which present greater challenges.

It was noted that Sections 4.4.3, 4.4.8, 4.9, and 4.11 were omitted from the core performance requirement list. These should be added back to the list with the possible exception of 4.4.3, which the contractor has less influence on.

TABLE 4. Proposed Vs. Recommended Percentage of Total Incentive Fee By Category

Incentives	Proposed	Recommended
Cost	33.3	40
Schedule	33.3	25
Performance	33.3	35
Total	100%	100%

DIRECT COSTS

A top level comparison of the contractor proposed, the in-house estimated, and the recommended hours and costs is shown below. The in-house estimates were performed by the HST Instrument Development Manager in April 2000. Note that the in-house estimates have work starting from April 2000 while the proposal has work starting in June 2000.

TABLE 5. Top Level Comparison of Proposed, Recommended, and In-House Cost Estimates.

	PROPOSED	RECOMMENDED	IN-HOUSE ESTIMATE
LABOR HOURS	211,495	198,858	143,395 HOURS
COMPUTER HOURS	12,494	11,699	45,417 HOURS
MATERIALS COST	[redacted]	[redacted]	$[redacted]
TRAVEL COST	$[redacted]	$[redacted]	$[redacted]
TOTAL COST	[redacted]	Not calculated	$[redacted]

The rationales for the differences between the proposed and recommended numbers are discussed in subsequent sections.

The in-house estimated total labor hours are less than 30% different from the proposed numbers after accounting for the two months cost estimation duration difference. However, with labor and computer hours combined, the in-house estimated hours are less than 20% different than proposed - this is fairly accurate considering the in-house estimate was calculated by primarily one person two months earlier in the program, while the proposal estimates were provided by the [redacted] subsystem lead engineers with two extra months of information and knowledge.

The in-house estimated material cost is also less than 30% different than proposed. However, the in-house estimated travel cost is over twice that proposed. This vast difference can be traced to the recent intention of the contractor to minimize travel costs as much as practicable by not bringing all its lead engineers to all the monthly reviews as estimated in the in-house numbers.

The in-house total cost is very close to that proposed. Overall, the in-house numbers are within 30% of those proposed. The basis of estimate for each will be compared and analyzed when appropriate to support the recommendations provided in this evaluation.

Labor

The proposed and recommended labor hours for each third level WBS element are shown in Attachment 1 along with the delta values in terms of labor types for pricing purposes. The rationale for accepting or recommending differently is provided in the last column of the table.

Besides calculating if the number of hours reflect the scope of work, the labor hours were also compared to those of the Advanced Camera for Surveys (ACS) and Cosmic Origins Spectrograph (COS) instrument proposals when the scope of work is similar. The labor hours were also compared to the in-house estimate. In general, the proposed hours are appropriately lower than the ACS or COS numbers by approximately 20% to 50% for work that is similar or the same. If the work is the same or similar but the hours do not reflect the appropriate cost savings without an acceptable basis of estimate, the proposed hours are proportionately reduced citing lack of cost savings due to heritage and/or re-use. In a few areas, it seemed that the basis of estimate is inconsistent with the scope of work [redacted] will provide to WFC3 which is different from previous [redacted] HST instrument where [redacted] managed and built the whole instrument.

The labor hours were also compared to the in-house cost estimate. Many of the WBS element hours compared well (less than 30% difference), however, the majority of the WBS elements did not. This is partly due to the fact that the proposed WBS breakdown and the in-house WBS breakdown are different enough that the work elements do not match well enough to make a direct comparison. Also, there were WBS elements called out in the proposal that were not in the in-house estimate, and vice versa. It is also noted that in certain cases, the hours differ significantly simply because the contractor has had the opportunity to perform preliminary engineering for the cases and therefore understand the scope of work better than the in-house estimator.

While Attachment 1 provides detailed labor hour comparisons with comments for each third level WBS element, Table 6, shown below, provides a summary of the labor hour comparison to the second WBS level.

TABLE 6. SUMMARY OF LABOR HOURS EVALUATION.

WBS #	WBS ELEMENT	PROPOSED HRS	RECOMM. HRS	DELTA
3.01	System Engineering	15720	15720	0
3.02	Optical Subsystem	25392	24078	1314
3.03	Detector Subsystem	30464	30423	41
3.04	Electronic Subsystem	34654	32534	2120
3.05	Software Subsystem	14025	14025	0
3.07	Mechanical Subsystem	41672	39483	2189
3.08	Optics Assy. I&T	12664	12664	0
3.10	Support Operations	5280	8160	ADD 2880
3.11	Product Assurance	16377	8868	7509
3.12	Program Management	15247	12903	2344
TOTAL		**211495**	**198858**	**-12,637**

Computer Usage

[redacted] uses the Pro-Engineering CAD software to design the parts/assembly and to develop (draft) the fabrication drawings. The computer usage hours are generally consistent with the number of design and drafting hours proposed except in a few instances as noted in Attachment 2. The total proposed computer hours are 12,494 hours. After reviewing the basis for the estimated hours, I am recommending 11,699 hours, or 795 hours less than the contractor proposed. My rationale for accepting or recommending otherwise is provided for each WBS element in Attachment 2.

Materials

The total proposed material cost of $[redacted] is recommended to be reduced by $146,608 to be $[redacted]. This cost includes the direct materials, major procurements, and subcontracts to be

provided by the contractor. Attachment 3 summarizes the material cost evaluation for each WBS element to the third level and provides the rationale for each recommendation.

Travel

The proposed travel plan, costing a total of $[redacted] and summarized in Attachment 4, is acceptable. Although the proposed number of trips for the miscellaneous technical and programmatic reviews/meetings (15 proposed) is high by about 15 person trips, it makes up for the too few number of travelers (4) for the MSR's and the omission in trips to JPL to coordinate or work SOFA issues (up to 2 trips with 3 person per trip for 2 days each). The MSR traveler shortage can also be increased by the fact that there will only be 12 instead of 14 proposed MSR's that the contractor will have to travel to.

Other than the exceptions mentioned above, all other travel destinations, purposes of trips, number of trips, persons per trip, and days per trip (as shown in Attachment 4) are appropriate and reflect the needed travel to support the program.

In summary, the total proposed travel plan balances out and is appropriate for the level of support to be provided.

COMMENTS

I believe this proposal exhibits a firm and realistic commitment to support the WFC3 program. I have taken relatively minor exceptions to the labor hours, computer hours, materials cost, and fee structure. The reason the exceptions are not significant is because I feel that Ball understands the scope of work well; Ball has performed an intense system engineering effort for the past year and have started detailed designs in most areas. I take no exception to any other proposed effort.

The BATC team is commended for pulling this proposal together within a very tight time frame that was also interrupted by having to prepare for and present a major briefing to a NASA Headquarter sponsored team.

The proposal is generally fair and reasonable. I recommend that we proceed to the negotiation process as soon as possible.

TECHNICAL EVALUATION SIGNATURE PAGE
FOR
[redacted] PROPOSAL [redacted]
"WIDE FIELD CAMERA 3
SCIENCE INSTRUMENT SUBSYSTEMS"

Thai Pham
WFC3 Instrument Manager

7-26-00
Date

CONCURRENCE:

for Bryan A. Fafaul
Instrument Development Manager
HST Development Project

7/27/00
Date

APPROVAL:

Frank J. Cepolline
Project Manager
HST Development Project

7/27/00
Date

Dave Scheve FOR
Associate Director of Flight Projects
For HST

7/27/00
Date

ATTACHMENT 1. PROPOSED VS. RECOMMENDED LABOR HOURS BY WBS

WBS #	WBS ELEMENT	PROP'D HRS	REC. HRS	DELTA	COMMENTS
3.01	SYSTEM ENGINEERING				
3.01.1	WFC3 Systems Engineering	7520	7520	0	This covers 1.5 EP for the program until delivery which is appropriate and therefore is acceptable.
3.01.2	WFC3 Structural Analysis	3400	3400	0	This assumes that about ¼ of drawings will need to be analyzed, which is low, but sinc 16 structural analysis hours were assumed p dwg, which is conservative, so the hours should be sufficient if not a little low. Also, the total hours is about ¼ of the tot designer hours which is consistent with the typical analytical support.
3.01.3	WFC3 Thermal Analysis	1654	1654	0	This effort is about 70% of that of ACS plus the consulting and interfacing time to support the Goddard/[redacted] thermal efforts so it is adequate and acceptable.
3.01.4	WFC3 M&P / Contamination	2786	2786	0	This is 55% of what was proposed for COS, so it is a little high but stil reasonable considering the optics assembly will be put together by BAT
3.01.5	WFC3 Mass Properties	360	360	0	This is an acceptable level of effor considering [redacted] will perform mass properties analysis for the [redacted] provided components and subassemblie only. Goddard/[redacted] will take care of the instrument level mass properties analysis.
3.02	OPTICAL SUBSYSTEM				
3.02.0	Optics Management	3040	3040	0	This level of effort will cover the [redacted] Optics Lead through Dec of 01. Thereafter, the [redacted] I&T Manager wil take over this task.

3.02.1	Flight Optics	4216	4216	0	This covers the design, fabrication, assembly and test of the UVIS and IR imaging optics and flight alignment cubes. The proposed hours are appropriate to support the dual channels.
3.02.2	Calibration Subsystem Optics	1380	1380	0	The design hours are based upon similarity to ACS and STIS for the optical elements and Tungsten lamps and similarity to COS for the IST Deuterium lamps, and therefore are appropriate for the WFC3 effort.
3.02.3	Non-Flight Optics	3740	3740	0	This estimate is based on the first time build of the STIS alignment station. The amount of complexity i comparable and therefore the hours are acceptable.
3.02.4	RCP Development Test	816	816	0	This is acceptable considering it covers the testing of all the optica elements mounts to evaluate their distortion and pointing errors, and the refractive corrector plate (RCP) mount testing effort takes up half o these hours. The RCP design is new and very challenging.
3.02.5	Optics GSE	12200	10886	Reduce SR ENG by 200 hours, ENG/TS1 by 100 hours, and SR MACH by 1014 hours for a total of 1314 hours	The fabrication estimate per job is over $[redacted]. This is inconsistent with most of the other fab estimate of $[redacted] per job. In addition, this is for GSE/fixtures which should not requir the accuracy and precision that othe flight parts do.
3.03	DETECTOR SUBSYSTEM				
3.03.1	UVIS Detector Assembly	7572	8191	Decrease ENG/TS2 by	Simply revising approx. 68 ACS dwgs for traceability to WFC3 and

				344 hours and PR ENG by 400 hours. Add 1363 SR MACH hours Total increase of 619 hours	developing 10 new dwgs should take about 872 LH (10x60 + 68x4 = 872) or 744 LH less than proposed (1616-872=744). However, during fact finding, [redacted] acknowledged that 4089 hours for the flight detector piece part fabrication was inadvertently omitted. 4089 hours would cover fabrication of 3 sets of housings. However, the recent plan is to use an existing ACS detector as our surrogate, and the ACS instrument manager has informed me that there should be at least enough hardware left from ACS to assemble one flight unit. This leaves one unit to be build or 1/3 of 4089 which is 1363 hours. So the net result is 1363 - 744 = 61 hours to be added.
3.03.2	IR Detector Assembly	20892	20232	Reduce SR MACH by 660 hours.	The assumption of 132 machining jobs at 30 hours per job is high. Since three sets will be built, there should be a saving in nonrecurring costs such as machine setup time. A 25% saving for each of the last two sets is reasonable for a total reduction of 660 hours (2/3 * 132=88 88*30*.25=660).
3.03.3	Detector Assembly Options	2000	2000	0	This includes the design, fabrication, assembly and test of th UVIS and IR detectors vent line assemblies and off-chip amplifier fo the IR detector. The proposed hours are reasonable and acceptable.

3.04	ELECTRONIC SUBSYSTEM				
3.04.0	Electronics Management	3163	2763	Reduce by 400 PR ENG hrs.	Electronics management should be closer to 75% of the ACS actuals considering most of the electronics have heavy ACS and COS heritage.
3.04.1	SOFA Electronics	820	820	0	This effort is appropriate to suppor the flight and non-flight diode steering and optical switch interfac boards.
3.04.2	Control Section	2644	2644	0	This is approximately 75% of the COS effort which is accurate and reasonable.
3.04.3	SES & MEB Electronics	2541	2241	Reduce 150 PR ENG hours and 150 ENG/TS2 hours for a total of 300 LH reduction.	The SES should be more like 75% of that of COS considering the heavy design leverage.
3.04.4	LVPS Electronics	4126	3606	Reduce 260 hours each from PR ENG and ENG/TS2 for a total of 520 LH.	The LVPS was priced at 15% higher than that of ACS to compensate for a 15% higher in complexity but it did not take into account for the 85% less complexity due to design heritage.
3.04.5	Ancillary Electronics	4448	4448	0	The ancillary electronics is not 50% more involved than that of ACS as priced - one third more involved is reasonable. However, since [redacted] has agreed to design and fab the SOFA flight electronics also, this number is acceptable.
3.04.6	DEB Electronics	6222	6222	0	This is a relatively new box with some heritage from NICMOS. It is the most complicated design for WFC3

					because it has the least design leverage. Labor hour estimate is reasonable and acceptable.
3.04.7	CEB Electronics	3280	2880	Reduce PR ENG hours by 400	This is a build to print activity an should not require so much principal engineering time.
3.04.8	Cables	4745	4745	0	The proposed hours are acceptable fo the task. This is about 50% more than proposed for COS but WFC3 cable harness is much more involved becaus we have more electronic boxes that are more spread out around the instrument.
3.04.9	Electrical GSE	2665	2165	Reduce PR ENG hours by 100, ENG/TS2 by 300, and ENG/TS1 by 100.	The electronic GSE heritage from COS and ACS is underestimated. 10% less LH than that of ACS is conservative but more reasonable.
3.05	SOFTWARE SUBSYSTEM				
3.05.1	Software Management	1429	1429	0	This includes the hours to coordinat and manage the software/ops tasks at the program level and covers the cod and unit test phase through the end of software qualification testing. I is reasonable and acceptable.
3.05.2	Flight Software	11148	11148	0	This includes the Control Section design, code, unit test, I&T, and final qual testing which is a significant amount of work. The estimated hours are consistent with the 10,850 hours in-house estimate and are acceptable.
3.05.3	GSE Software	1448	1448	0	This is consistent with reusing 75% of the ACS codes which is the accurate amount of reuse calculated.

3.05.4	Operations	-	-	-	Labor is being supplied by Goddard but is not considered part of this proposal.
3.07	MECHANICAL SUBSYSTEM				
3.07.0	Mechanical Management	3360	3360	0	This is acceptable because it covers one EP to manage the mechanical effort through delivery to Goddard.
3.07.1	Calibration Subsystem	5510	5510	0	This is acceptable because it covers the design, fabrication, assembly, and testing of the calibration subsystem which covers both channels and includes deuterium and tungsten bulbs. A spare set of parts will als be fabricated.
3.07.2	IR Cold Enclosure	694	694	0	Proposed hours are reasonable and acceptable considering the cold enclosure design is new with no heritage to leverage from.
3.07.3	Optical Bench & Enclosure Liaison	600	600	0	Proposed hours are appropriate to cover the needed communication because different partners are involved for the Optical Bench and Enclosure development. This is very close to the in-house estimate of 66 hours.
3.07.4	Optical Mounts	5149	5149	0	Proposed hours include 2060 hours of design time, 2963 hours of fabrication time, and 126 hours of test time. This is appropriate for about 60 types and 90 pieces and therefore, are acceptable.
3.07.5	Baffles	2213	1613	Reduce ENG/TS2 by 600 hours	The 20 baffle drawings estimated at 60 hours each should equate to 1200 hours and not 1800 hours as quoted.
3.07.6	Corrector Mech's & IR Filter Wheel	12363	12363	0	Fact finding sessions revealed that this effort includes design,

					fabrication of 5 corrector piece parts sets, and assembly of 3 correctors only - not all 5 units. Instead of adding time to assemble the fourth unit, we decided to just fab and assemble 4 units total. The fab cost savings from the proposed fifth unit is assumed to make up for assembly cost of the fourth unit.
3.07.7	Mechanical GSE	6184	5184	Reduce SR MACH by 1000 hours	These labor hours will support the design, fabrication, assembly, and testing of all the lifting/handling equipment, shipping containers, mass simulators, and detector or alignmen tooling provided by the contractor. The labor hours are overestimated because the MGSE to be provided are not complex or high cost items and the pick-off mirror shipping container is already available.
3.07.8	Channel Select & Shutter Mechanisms	4254	3915	Reduce SR MACH by 339 hours	The channel select mechanism fabrication hours were reduced by 33 hours to 1440 by [redacted] during fact finding.
3.07.9	SOFA Mounts	1345	1095	Reduce ENG/TS2 by 200 LH and DRFT/GPH by 50.	The SOFA mounts should be simpler than originally thought especially now that it has been decided that th support struts are not needed. This effort should not take a total of 4 man months to complete.
3.08	OPTICS ASSEMBLY INTEGRATION & TEST				
3.08.0	I&T Management and Procedures	1760	1760	0	This covers the [redacted] I&T manager ful time from optical bench receiving through optical assembly testing and is reasonable and acceptable.
3.08.1	I&T Support	10904	10904	0	This includes optical, software/ops, mechanical, and electrical support

					for the optical assembly I&T effort. The total hours are reasonable and acceptable.
3.10	SUPPORT OPERATIONS				
3.10.1	GSFC Post-Delivery Support	2880	5760	Double the proposed support type and hours.	This only includes 2 full time persons for the 9 months period I&T at Goddard - an optical/elec enginee and an optical/elec tech. This is a insufficient level of support and should be doubled.
3.10.2	KSC Support	1920	1920	0	This is reasonable and acceptable although all this support may not be necessarily at KSC. Some of these hours will be used to support pre-KS delivery since we will not be there the whole 6 months as proposed.
3.10.3	Post Launch Support	480	480	0	This is appropriate and will support two engineers quarter time for six months after launch.
3.11	PRODUCT ASSURANCE				
3.11.1	Quality Management & Inspection	10482	4193	Reduce all labor types by 60% for a total of 6289 hours.	Considering the contractor is responsible for approximately 60% of all the flight hardware and will not be responsible for system level QA and the fact that EEE parts will be screened and provided by Goddard, th proposed hours should be about 40% o that proposed for COS or 4193 hours.
3.11.2	Reliability	634	934	Add 150 hours each to PR ENG and SR ENG for a total of 300 hours	The contractor's responsible hardwar will drive the majority of the required reliability analysis (FMEA, worst case analysis, trend analysis, reliability predictions, etc…) and therefore the hours should represent about 80% of those of the COS instrument.

3.11.3	Safety	420	210	Reduce PR ENG by 210 hours	The majority of the safety support should come from the HST core safety team since the contractor will only be providing subsystems.
3.11.4	Parts Engineering	2619	1310	Reduce all labor types by 50% to 1310 hours total.	The proposed hours are inappropriately consistent with previous HST work when the contracto was responsible for developing the total instrument. This support should be sufficiently provided by a equivalent of one person 1/3 time until hardware delivery.
3.11.5	Software QA	2222	2222	0	These hours are reasonable and consistent with keeping a software engineer half time for about 2 years - which is the appropriate effort.
3.12	MANAGEMENT				
3.12.2	Configuration & Data Management	3552	2368	Reduce ENG/TS2 by 1184 hours	The proposed hours are inappropriately consistent with previous HST instrument work when th contractor was responsible for developing the total instrument. This work should accomplishable with 1/3 the amount of hours proposed.
3.12.3	Program Administration	3975	3475	Reduce SR AD/SPVR hours by 500	The proposed hours should not be consistent with other HST instrument since the contractor's effort is les for WFC3, and support after Optical Assembly delivery in May 02 should b significantly less than the half tim proposed.
3.12.4	Program Management	6080	6080	0	The proposed hours appropriately accounted for less time required after optics assembly delivery and are therefore reasonable and acceptable.
3.12.5	Publications	560	300	Reduce AD/SPVR2	The contractor will be asked to prin MSR packages every other month only

				hours by 260	and the CDR package will be printed by Goddard.
3.12.6	Logistics	1080	680	Reduce ENG/TS2 by 400 hours	Logistic support for the next 21 months should be minimal and 20 hours/month should be adequate.
TOTAL		**211,495**	**198,858**	**12,637 LESS THAN PROPOSED**	

ATTACHMENT 2. PROPOSED VS. RECOMMENDED COMPUTER HOURS BY WBS

WBS #	WBS ELEMENT	PROP'D HRS	REC. HRS	DELTA	COMMENTS
3.03.2	IR detector design and drafting	2200	1975	-225	The proposed flight detector drafting hours are equal to the design hours. This seems inappropriate because the Pro-Engineering C software [redacted] uses should be able to facilitate the conversion of the design models to fabrication drawings quickly and therefore reduce the number of drafting hou by about one quarter including assembly drawing time.
3.03.3	Detector vent design and drafting	640	560	-80	Same reason as above.
3.07.0	Verify design work and prepare presentation slides	672	672	0	Over 10,000 computer hours for design and drafting time will be performed - making th number only about 5% of the design and drafting time which is reasonable and acceptable. This number also includes supporting over 26 presentations that will require CAD drawing representations.
3.07.1	Calibration Subsystem	1440	1440	0	The calibration platform and optics is a ne design with challenging packaging issues since it was the last component to be designed into an existing Optical Bench design. Therefore, this number is appropriate.
3.07.2	IR Cold Enclosure	280	280	0	This component will be sent out of house fo fabrication so it is important that it is designed and drafted correctly because it c be very costly to hold up subcontractor fabrication line. This number is very reasonable considering the complexity of th cold enclosure with interfaces to the bench

					detector, and filter wheel.
3.07.3	Optical Bench & Enclosure Liaison	410	480	70	The optical bench component installation drawings will require approx. 80 hours to complete and not 10 hours as proposed. The are over ten subsystems to be installed int the optical bench times 8 hours each including checking time.
3.07.4	Metrology and optical assemblies	1740	1740	0	There are over 10 optical assemblies so thi means approx. one month computer time each. This is reasonable considering there will b simple and complex assemblies that will mak up for each other and average about a month each.
3.07.5	Baffles	1120	720	-400	It is estimated that there will be 12 baffl requiring 60 hours each for design and drafting totaling 720 hours. The proposed number is too conservative.
3.07.6	Corrector Mech's & IR Filter Wheel	828	828	0	This is reasonable because the IR filter wheel design and drafting alone will requir over 700 hours. The filter wheel fits onto the cold enclosure so it will require caref CAD integration of the two designs.
3.07.7	Mechanical GSE	2160	2000	-160	The pick-off mirror shipping container will be GFE.
3.07.8	Channel Select & Shutter Mechanisms	604	604	0	This includes design and drafting time of t mechanisms, so it is very reasonable.
3.07.9	SOFA Mounts	400	400	0	This is acceptable because the SOFA fits ve tightly into the optical bench and therefor requires thorough design efforts.
TOTAL		**12494**	**11699**	**795 LESS THAN PROPOSED**	

ATTACHMENT 3. MATERIALS, PROCUREMENT, & SUBCONTRACT COSTS BY WBS

WBS #	WBS ELEMENT	PROP'D COST ($)	RECOM. COST ($)	DELTA COST ($)	COMMENTS
3.02.1	Flight Optics (procurement)	[redacted]	No Change	0	This is reasonable for 16 mirrors (prime and spare), 50 optical witness samples, and 15 alignment cubes. The manufacturer, Tinsley, provided quotes were included in the proposal. Tinsley is very qualified and has the most HST experienced of all the optics manufacturer.
3.02.2	Calibration Subsystem Optics	[redacted]	No Change	0	This includes the Deuterium and tungsten calibration lamps, mirrors, beam splitter, and diffusers and their spares. Acceptable as proposed.
3.02.5	Optics GSE	[redacted]	No Change	0	This includes over 18 optical fixtures. Acceptable as proposed.
3.03.1	UVIS Detector Assembly	[redacted]	51,500	-102,994	This estimate assumed the material cost to build 3 sets of UVIS housing. Since the surrogate detector will now be one of ACS' detectors, and there should be at least one useable set of ACS spares for our use, 2/3 of this cost is reduced.
3.03.2	IR Detector Assembly	[redacted]	No Change	0	This covers all detector materials including the 6 stage TECs, hermetic connectors, indium seal wires, PWB's, and raw metal stock. Acceptable as proposed.
3.03.3	Detector Assembly Options	[redacted]	No Change	0	This is for the external venting option for both channels and the IR detector off-chip amplifier circuit. It includes all piping, valves, seals,

					and flanges. Acceptable as proposed.
3.04.2	Control Section	[redacted]	No Change	0	This covers 16 boards, 8 flights and 8 for use on test benches. This is less than $4000 per board, which is reasonable and acceptable.
3.04.3	SES & MEB Electronics	[redacted]	No Change	0	This covers 24 boards, 12 flights and 12 for use on test benches and includes material for box chassis. This averages to a little over $5000 a board and the cost of the chassis ($20K to $30K) which is reasonable and acceptable considering these boards are more complex than the Control Section boards.
3.04.4	LVPS Electronics	[redacted]	No Change	0	This covers 20 boards, 10 flights and 10 for use on test benches and includes material for box chassis. This is consistent with the board and chassis costs for the SES and MEB. Acceptable as proposed.
3.04.5	Ancillary Electronics	[redacted]	No Change	0	This includes materials for 2 detector electronics filter boxes, the heater power distribution box, calibration lamp controller, 4 thermal controllers and 2 engineering models (CLC and TC). Acceptable as proposed.
3.04.6	DEB Electronics	[redacted]	No Change	0	This covers 2 boards, a motherboard and chassis for a flight and an engineering unit. This equates to six boards of about $6000 each because of lower design heritage and the cost of the chassis. Acceptable as proposed.
3.04.7	CEB Electronics	[redacted]	80,000	-25,114	This covers 4 boards and the detector amplifier board for a flight and an engineering unit. Assuming $5000 a board, 10 boards yields about $50,000 plus $30k for the chassis equals $80,000. This estimate seems to be

					high by about $25K. The CEB is a duplication of the ACS unit and therefore should not be foreign to the Ball electricians. The piece parts cost is given as being about $98.5K, but high cost EEE parts will be GFE.
3.04.8	Cables	[redacted]	No Change	0	This is reasonable because WFC3 has an large amount of cable routing because there are 14 electronics boxes that are spread out and not consolidated like the axial instruments.
3.04.9	Electrical GSE	[redacted]	No Change	0	This covers power supplies and other miscellaneous electronics necessary to perform various types of electrical integration and testing. Acceptable as proposed.
3.05.0	Software Management	[redacted]	No Change	0	This covers the materials necessary for the flight software-image analysis workstation. Acceptable as proposed.
3.07.1	Calibration Subsystem	[redacted]	No Change	0	2 boards with high voltage components make the cost about $10K each and the cost of the chassis. Acceptable as proposed.
3.07.2	IR Cold Enclosure ($80,060 subcontract)	[redacted]	No Change	0	This includes metal matrix material and other metals. This cost includes the cost for Applied Aerospace Structures Corporation to build the enclosure. The AASC ROM quote is provided in the proposal. Acceptable as proposed.
3.07.4	Optical Mounts	[redacted]	No Change	0	The mounts are made of Invar and Titanium which are expensive metals and there are many mounts. Acceptable as proposed.
3.07.5	Baffles	[redacted]	3,493	-18,500	This cost includes the cost of 10 accelerometers at $1,850 each. This seems out of place.

3.07.6	Corrector Mech's & IR Filter Wheel	[redacted]	No Change	0	This is acceptable as it includes costly motors for all four corrector units to be build. Each unit requires 3 motors that are about $25K - $30K each. The filter wheel also requires 2 motors.
3.07.7	Mechanical GSE	[redacted]	No Change	0	This covers the cost of all the materials used to build handling fixtures, detector tooling, target plates, and simulators. Acceptable as proposed.
3.07.8	Channel Select & Shutter Mechanisms	[redacted]	No Change	0	This includes the cost for the motors, Titanium and other stainless materials which are costly but needed. Acceptable as proposed.
3.07.9	SOFA Mounts	[redacted]	No Change	0	Acceptable as proposed.
TOTAL		[redacted]	[redacted]	**$146,608 less than proposed**	

ATTACHMENT 4. TRAVEL COSTS

#	Destination	Purpose of Trip	No. of Trips	Persons per Tri	Days per Trip	Total Costs
1.	Los Angeles, CA	IR Detector Coord. Meeting with Rockwell	2	3	2	9,300
2.	Baltimore, MD	MSR at Goddard	14	4	2	96,936
3.	Baltimore, MD	OB CDR/Stimulus Peer Review	1	5	2	8,605
4.	Baltimore, MD	SE Peer Review	1	3	2	5,243
5.	Baltimore, MD	Misc. Tech/Program Reviews	15	3	2	78,645
6.	Baltimore, MD	CDR at Goddard	1	8	4	17,096
7.	Baltimore, MD	PER at Goddard	1	6	2	10,386
8.	Baltimore, MD	Logistic Planning Meetings	2	2	2	6,924
9.	Baltimore, MD	Logistics Support, OA Delivery	1	4	5	9,360
10.	London, England	CCD Detector Coord. Meeting with Marconi	2	3	5	23,781
11.	Baltimore, MD	Optical Bench Coord. Meeting	1	1	2	1,781
12.	San Francisco, CA	IR housing vendor	1	1	2	1,781
13.	Seattle, WA	UVIS Connector Welding Vendor	1	1	2	2,094
14.	Baltimore, MD	Goddard Post Delivery Support	10	2	27	149,620
15.	Orlando, FL	KSC I&T Support	7	2	27	93,128
16.	Baltimore, MD	Post Launch Support	7	1	27	52,367
TOTAL						**567,047**